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Hartley, Edward
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[FROM THE REPORTS OF THE GEOLOGICAL SURVEY OF CANADA FOR 1867-1869.]

NOTES

ON

COAL FROM SPRINGHILL,

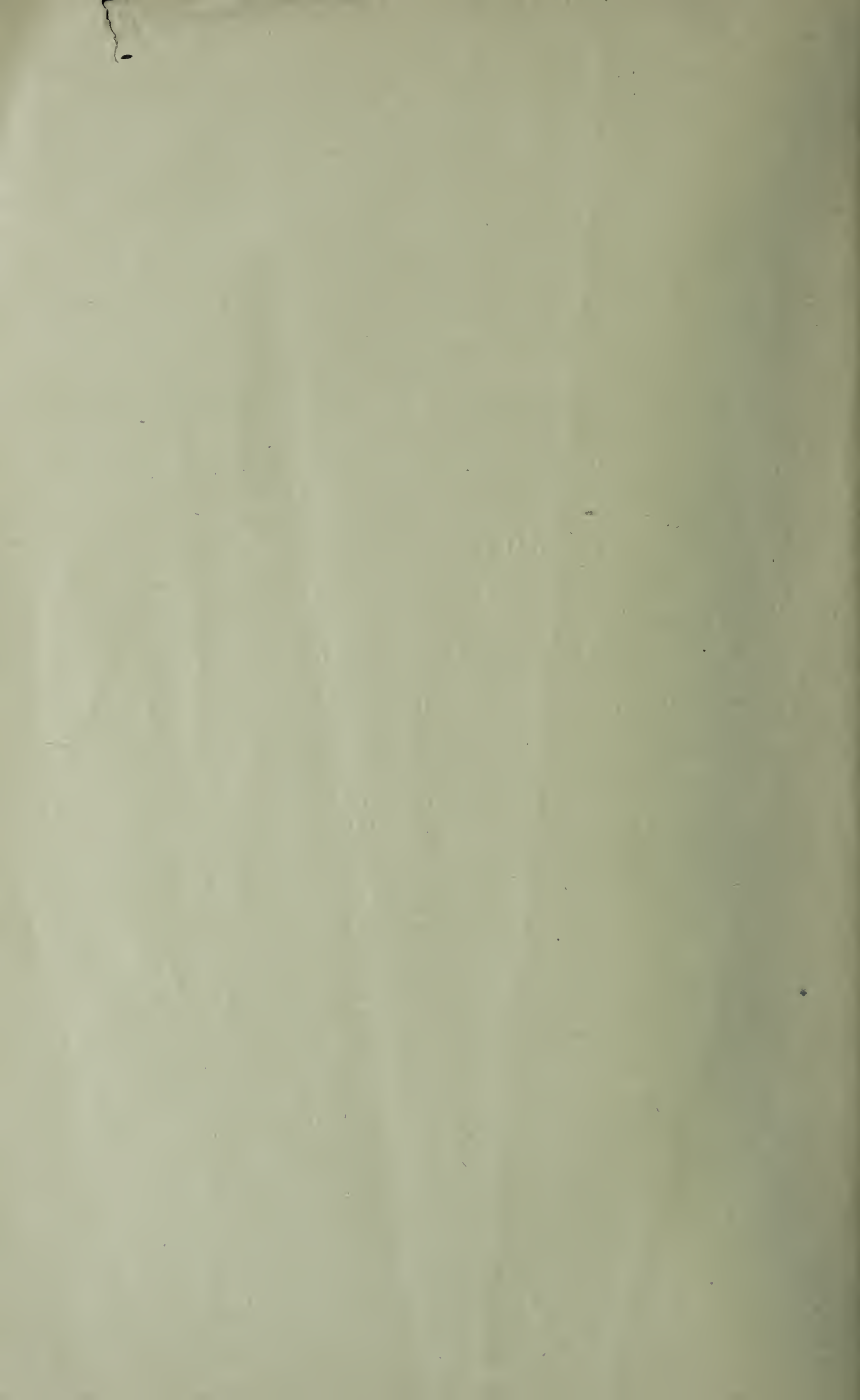
COUNTY CUMBERLAND, NOVA SCOTIA,

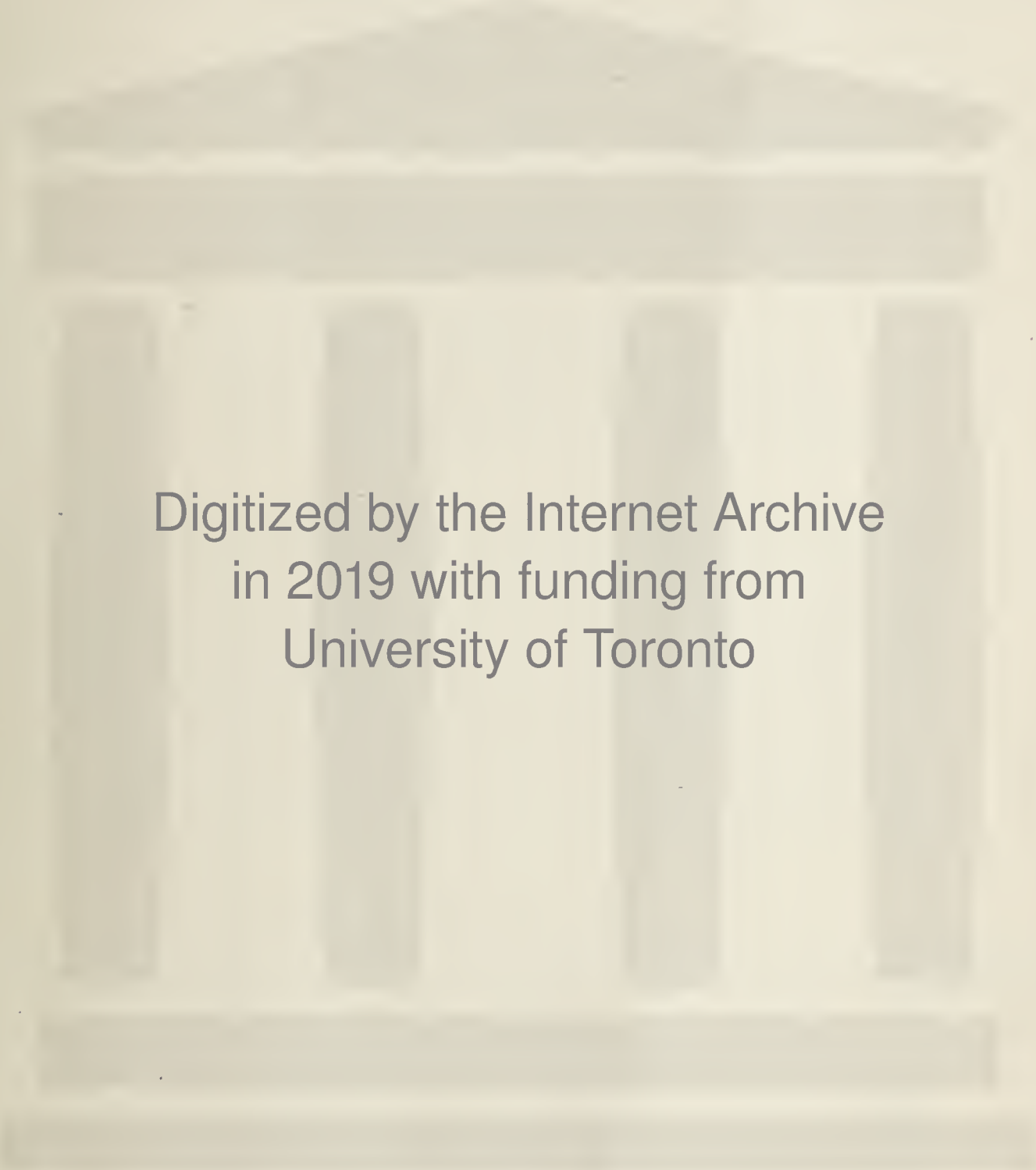
BY

EDWARD HARTLEY, F.G.S.,

MINING ENGINEER TO THE GEOLOGICAL SURVEY OF CANADA.

[Montreal, 1870?]]





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NOTES

ON

COAL FROM THE SPRINGHILL COAL-FIELD,

COUNTY CUMBERLAND, NOVA SCOTIA,

BY

EDWARD HARTLEY, F.G.S.,

MINING ENGINEER TO THE GEOLOGICAL SURVEY OF CANADA, MEMBER OF THE NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS AND OF THE INSTITUTION OF ENGINEERS IN SCOTLAND.

In the month of June, 1869, I had the honour to present a Report to Sir William E. Logan, F.R.S., Director of the Geological Survey of Canada, giving the result of a special examination of a box of coal samples, from the Main seam of the Springhill coal-field, County Cumberland, Nova Scotia. The facts contained in that Report are now included in the following paper, together with a few notes of interest concerning this important coal-field, which I have been able to obtain through the kindness of the Honourable Dr. Chas. Tupper, C.B., and M.P., for County Cumberland.

EXAMINATION OF MAIN SEAM COAL.

The samples of coal examined were taken from the Main seam of the Springhill coal-field, and were obtained at the "Black Mine." The sample box contained about sixty pounds of coal (round and slack). Springhill Main seam.

An examination of the external character of this coal shows it to be a bituminous coal of a moderately compact texture, and not inclined to fall to pieces, or *slack*. Its colour is a bright brownish-black, brilliant, except on the faces of the *partings*, which show a few patches of mineral charcoal. But a small proportion of the sample shows a shaly lamination, or tendency to break with the planes of deposition. It has a tendency rather to break with the cleat and cleavage-planes, which are inclined to the deposition-planes at angles varying from 65° to 75° , and occasionally 80° , giving irregular surfaces, known technically as *crystalline* faces.

Four samples were taken for analysis:—I and II were two

averages of the whole box ;—III was a picked sample of the best (most compact) coal, and IV. was a specimen of the coal showing a shaly texture. The results of proximate analysis in the laboratory were as follows :—

	HARTLEY.			
	I.	II.	III.	IV.
Analyses.				
Hygroscopic moisture	1.21	.98	.58	1.28
Volatile combustibile matter	33.08	35.52	33.27	35.66
Fixed carbon	61.49	59.42	63.85	58.53
Ash, (perfectly white)	4.22	4.08	2.30	4.53
	100.00	100.00	100.00	100.00
Coke	65.71	63.50	66.15	63.06

Sample I was carbonized by a slow and careful application of heat ; but in treating II the heat was suddenly applied, and the carbonization effected as rapidly as possible. Analysis I thus shows the smallest amount of volatile matter obtainable from the coal, and II the largest. Determinations were made of the sulphur in sample I, with the following results :—

	Per cent.
Total amount of sulphur in coal	0.225
Amount of sulphur in ash, (as gypsum)	0.108
“ “ “ as iron pyrites, by difference	0.117

The analyses show this coal to belong to the class known as highly bituminous, or *fat* caking coals, in character very similar to those of the North of England, known as North Country, or Newcastle-Hartley coals.

Value for gas meeting.

The high rate of volatile to fixed combustibile matter should render this coal, in common with the Newcastle coals which it resembles, an admirable gas-coal, while in the amount of sulphur it falls much below the average of Newcastle coals (which contain about nine-tenths of one per cent, as determined by the Admiralty steam-coal trials) ; therefore the gas obtained from it should be very easily purified.

For iron-smelting.

The coke of this coal appears in every way well adapted for iron-smelting, as it is firm, and rather compact, and in content of ash and sulphur will compare most favourably with that from any coal of the Provinces. This coke is much more easily formed and of a better quality than from the greater number of Provincial coals. As the amount of ash is a most important point in iron-smelting, it may be well to give the following data concerning the ash content of other coals for comparison. They are taken from Professor W. R. Johnson’s Coal Trade of British America, (page 126) in his comparison of the Reports of the British and American Commissions, on coal trials :—

Ash.

	Per cent.
Average of ash in 30 British coals laboratory analysis	5.76
“ “ “ 35 American coals..... “ “	7.76

Showing in favour of average Springhill coal as compared with British Comparison.
coals, a balance of 1.61 per cent, and of 3.61 per cent., as compared with
American, in ash-content. For comparison with coals of the other
districts of Nova Scotia, it may be stated that Pictou coals average from
7 to 9 per cent. of ash ; Sidney (so far as published analyses show), from
5 to 7 per cent., and Cumberland (Joggins) coal from 5 to 6 per cent.

With regard to the use of this coal as a steam-producer, I would refer
the reader to the article “Remarks on the trials of steam-coals,” in my
recent Report on the Coals and Iron ores of Pictou County. (See extract,
pages 6 et seq.) in which it is shown that coals of this class are now burnt
with an evaporative power equal to that of the Welsh semi-anthracites, or Value as steam-
free-burning steam-coals. The remarks there made, calling attention to coal.
the importance of these trials to the Pictou coal trade, apply with greater
force to the coal under consideration than to Pictou coals, on account of
the nearer approach in character of the Springhill coal to those of New-
castle. At the date of my original Report on the Springhill Main-seam
coal, I was not possessed of any result of ultimate analysis, but attention
was then called to the resemblance of the coals in proximate constituents,
and the following analyses given : A—is an analysis of Hartley coal from Comparison
Newcastle-on-Tyne. B—an average of a number of analyses of Newcastle with coals of
coals (both A and B from the appendix to Richardson’s, Knapp’s Tech- Newcastle.
nology) ; and C—an average of analyses I and II of this paper ; being of
the Black Mine samples.

	A.	B.	C.
Volatile matter, water included	35.50	37.60	35.39
Fixed carbon	60.50	57.00	60.46
Ash	4.00	5.40	4.15
	100.000	100.00	100.00

Since the circulation (in manuscript,) of the original Report, I have
received an ultimate analysis of this coal, by Dr. John Percy, F.R.S., of Analysis by Dr.
the Royal School of Mines. This analysis was made by Dr. Percy some Percy.
years since, for parties interested in the Springhill coal-field, the specimen
analysed being a sample from the outcrop, of which the following proximate
analysis is given :—

	PERCY.
Coke	64.94
Volatile matter.....	31.08
Water.....	3.98
	100.00

The small amount of volatile matter, and the large amount of water
present in this sample, would lead me to believe that its quality was not
equal to that of the coal examined by me.

The following table gives Dr. Percy's analysis, and also analyses of the Newcastle coals used in the late British experiments on North Country coals, as noticed in the Report on Pictou coals, already referred to, the analyses of Newcastle coals being on the authority of the Reports of the British Commissioners in the Admiralty steam-coal trials. In these analyses no account of the moisture in the coals appears, and it is to be presumed that the samples of coal analysed were either dried before being treated, or that the amount of moisture was exceedingly small. Therefore, I have added a re-calculation of Dr. Percy's analysis, based on the supposition that the sample of Springhill coal was dried, (or disregarding water.) Analysis 7, of the following table is by Dr. Percy, of the coal from Springhill, including water, and 8 is the calculation from this analysis of the ultimate constituents of the dry coal.

Table of analyses.

NAMES OF COALS.		Carbon.	Hydrogen.	Oxygen and Nitrogen.	Sulphur.	Ash.	Coke.
NEWCASTLE COALS.							
1. West Hartley Main.....		81.85	5.29	9.22	1.13	2.51	59.20
2. Hastings Hartley.....		82.24	5.42	8.05	1.35	2.94	
3. Davison's West Hartley.....		83.26	5.31	4.22	1.38	5.84	59.49
4. Original Hartley.....		81.18	5.56	8.75	1.44	3.07	58.22
5. Cowpen and Sidney's Hartley.....		82.20	5.10	9.65	0.71	2.33	58.59
6. Derwentwater Hartley		78.01	4.74	12.15	1.37	3.73	54.83
SPRINGHILL COAL.							
7. Main coal, (outcrop) including 3.98 p. c. of water.....		75.51	5.00	9.37	1.09	5.05	64.94
8. Main coal, (dry).....		78.51	5.19	9.66	1.12	5.20	

GENERAL REMARKS ON THE COAL-FIELD.

General remarks.

Intercolonial Railway.

The Springhill coal-field is situated about twenty miles south-east of the Joggins shore, in County Cumberland, Nova Scotia. Whether it is to be considered a detached coal-field, or a portion of the great Cumberland coal-field of Nova Scotia, is still an open question, only to be decided by a careful geological survey. This region appears to warrant the most careful examination, from the fact that it is destined to become of the greatest importance to the Province, at no distant period. At present no active collieries of any extent exist in this coal-field, for want of communication with tide-water; but the completion of the Intercolonial Railway, (which will pass directly through some of the surveyed coal areas,) will effect communication not only with the Bay of Fundy, (at Amherst, about 22 miles distant), but with the Basin of Mines, Halifax, and many other points where the coal will be in demand; and no doubt a large amount

of the coal, or coke produced from it, will be consumed upon the railway. About thirty miles to the south of Springhill, the railway will pass through the property of the Acadian Iron Company, about two and one-half miles from the Acadian iron mines at Londonderry, thus connecting this important district with the coal-field. The Acadian mines are so well known, from many published reports and descriptions, that it seems unnecessary to give any description of them here, and in this connection it will suffice to say that the supply of iron ore of remarkably good quality thus brought in connection with a coal well adapted for smelting and puddling, seems, from all descriptions, to be practically almost inexhaustible. The main vein (on the authority of Messrs. Woodhouse and Jeffcock, Mining Engineers, of London,) has been traced for a distance of twelve miles from east to west, and it is stated that did the trade admit, numerous workings might be located thereon. The ore at the Acadian Iron works is at present smelted with charcoal, the iron produced being of the best quality, taking a rank in the English market, second only to the better brands of Swedish charcoal iron.

Acadian Iron Works,

The Springhill district may be divided into two sections—North and South Springhill. The Black Mine, from which the coal examined was taken, is situate in the South Springhill section, or on the southern outcrop of a coal-measure synclinal, the axis of which is nearly in an east and west direction. Five coal seams have been discovered in this section, and their relations and thicknesses are stated to be as follows, in descending order :—

Divisions of the coal-field.

Seam A—three feet in thickness.

“ B—thirteen feet in thickness, lately discovered on the “ McFarlane claim.”

Seams of South Springhill.

“ C—*Main Seam* ; eleven feet three inches in thickness, the coal of which has received especial attention in this paper.

“ D—three feet in thickness.

“ E—two “ “

The Report of the Provincial Inspector of Mines, for 1869 (page 22), states that the coal of all these seams is of excellent quality.

E. H.

MONTREAL, 28th June, 1870.

[EXTRACTS FROM A "REPORT ON COALS AND IRON ORES OF PICTOU COUNTY, NOVA SCOTIA,"
PAGES 426-431 OF THE REPORTS OF THE GEOLOGICAL SURVEY OF CANADA, 1867-69.]

GENERAL REMARKS ON STEAM-TRIALS.

General
remarks on
steam trials.

The general result of all the trials above described has been to demonstrate the fitness of the coals used, for steam production, whether under stationary marine or locomotive boilers. As the result of each separate trial can be compared with similar trials of foreign coals, by reference to any work on standard coals or engineering practice, it seems unnecessary to make any such comparison here.

Former pre-
judices against
bituminous
coals, as steam
producers.

A few remarks on late experiments on the consumption of such coals, however, may not be out of place, but though of very great importance to our coal trade, a full discussion of the subject will not be practicable, without extending this Report far beyond the limits to which it must be necessarily confined. A prejudice existed for a long period against using bituminous coals as steam-producers, especially in the Navy, on account of the large amount of smoke produced in burning them, and their low evaporative power, as compared with anthracites, or the so-called free-burning coals of the Welsh coal-fields. The heavy black smoke emitted from the funnel of a steamer burning these coals rendered them quite unfit for the use of ships of war, and in towns and cities became a serious nuisance. Their evaporative powers, as has already been stated, were supposed to be dependent on their content of fixed carbon, which supposition seemed to be quite justified by practical experiments. The most careful trials with the old style of furnaces failed to give them the value of the Welsh steam-coals, in proof of which I may cite the final results of the British experiments (De la Beche and Playfair's), in evaporative powers:—

Average of	37	samples from Wales.....	9.05	lbs.
"	17	" " Newcastle.....	8.37	"
"	28	" " Lancashire.....	7.94	"
"	8	" " Scotland.....	7.70	"
"	8	" " Derbyshire.....	7.58	"

Resemblance of
Pictou and
North Country
coals.

Of the above list of coals, the coals of the Pictou district approach nearer to the Newcastle Hartley, or North Country coals than to any other class well known, and it will be, therefore, of the greatest interest to show the change of opinion which has taken place with regard to these coals within the last few years; to mark how all the old prejudices have disappeared, and to ascertain with what success these coals are now consumed as steam-producers.

To accomplish this object in the most direct manner, I cannot do better

than quote from the “ Report of a Committee appointed by the North of England Institute of Mining Engineers, to investigate the smoke question” Smoke consumption. (dated Oct. 24th., 1860.) After mentioning the causes that led to the appointment of this committee, they state :—

“ They (the Committee) cannot, however, forbear remarking that there is really very little left for them to do. A few years ago, in 1855, there was an impression that North Country steam-coal not only made smoke when burnt, but was of an inferior evaporative power to that of the so-called smokeless Welsh coal. Since then, on two subsequent occasions, this has been proved, most satisfactorily, to be an error. In 1856-7, experiments were made at Elswick, conducted by Sir William Armstrong, Mr. J. A. Longridge and Dr. Richardson, which fully demonstrated that Hartley could Late experiments. give, without smoke, 12.9 lbs., and Welsh 12.35 lbs. of water evaporated from 212°, per pound of coal, in an ordinary marine boiler ; and in 1864, Mr. Miller, at the request of the House of Commons, made a series of experiments which proved again most satisfactorily that Hartley could give without smoke 10.68 lbs., and Welsh 10.13 lbs. of water evaporated from 100 per pound of coal. Again, at Wigan, in 1867, Messrs. Fletcher and Dr. Richardson conducted a series of experiments proving most conclusively that a bituminous coal, more difficult even to manipulate in the fire than the coal of this district, can be economically and *smokelessly* consumed. All these results have been accomplished with the smallest possible alteration of the furnace and bars of ordinary marine boilers. Your Committee, therefore, have, from many and various sources, the highest authority for stating that, as far as experiments can do so, the question is practically *solved*, and more particularly in connection with any ordinary quality of round coal, and in Cornish or marine boilers of ordinary construction. It could hardly be expected that any further experiments would produce better or more conclusive results, or be attested by gentlemen of higher reputation and position.

* * * * *

“ Believing, as they do, that the semi-bituminous steam-coal of this district can be burnt without smoke, so as to give as high, if not a higher and more speedy evaporative power, than Welsh (as might be expected from its chemical composition), your Committee can by no means aver that this most important fact is comprehended by the great bulk of consumers ; but they are not of opinion that any further experiments in this direction are necessary, as it seems to them that data on this subject are so numerous already, that the public may be properly left to draw their own inferences thereon.

“ If your Committee were asked for the reason for so much incredulity on a subject so important to the interests of the Northern coal-owners, they

would suggest that it, to a certain extent, arises from the fact that the steamships built in the neighbouring ports are not, as a rule, by any means successful either in their attempts to prevent smoke, or to obtain the highest results from the coal of the district. These steamers, going from port to port, and from country to country, assist in advocating the views of those who refuse to recognise the value of the Northern steam coals, and your Committee regret that the boilers of these ships at least are not constructed so as to bear out the results so laboriously obtained at such great cost.”*

Many of the statements in the above extract will apply with almost equal force to our own coals. It is scarcely possible that we shall obtain the very high results in evaporative power above indicated, from the Pictou coals, from the fact that the amount of ash in these coals almost invariably exceeds that in the coals of the North of England; but it is certain that with proper furnaces, the evaporative power of our coals may be materially increased, probably to the extent of from twenty-five to thirty per cent., and there seems no reason to doubt, that, in the matter of smoke, our coals may be as successfully burnt as those of the North Country.

Mr. Bunning's
experiments.

In this connection it will be interesting to examine into the success with which the Newcastle coals are burnt without smoke, and to this end, an abstract of the experiments of Mr. T. W. Bunning, of Newcastle-on-Tyne, on the steamer “*Weardale*,” will most conclusively show the wonderful improvements made from the results of the old system of burning the coals, by a very slight change in the furnaces and bars. A series of smoke-trials were made on this steamer with the ordinary furnace, fitted with grate-bars five feet long, and the exact amount of smoke produced by Hartley coal was obtained by a method presently to be described. An alteration was then made in the furnaces, which consisted simply in shortening the bars to three feet six inches, and introducing an *air-plate* (of fire-bricks with open spaces between them, hung on iron bars), at the back of the fire. Underneath this air-plate was a flue, or open space, separated from the ash-pit of the furnace by a cast-iron plate, carrying the brick forming the bridge proper of the furnace. This cast-iron plate was pierced with a hole giving communication between the ash-pit and air-plate flue, when open, and thus admitting air between the fire and the chimney, through the spaces between the fire-brick forming the air-plate; or this hole could be closed by a shovel-full of ashes and cinder. Beside these simple alterations the furnace-doors were fitted with perforated flash-plates, through which the air was allowed to pass into the furnace, in front of the fire, but above the grate. After the alteration, another series of experiments was tried with the steamer, and with the most signal success. The results were published in the Transactions of the North of England Institute of Mining Engineers, and accom-

* Transactions North of England Institute of Mining Engineers, vol. xviii, pp. 37-38.

pany a short paper by Mr. Bunning, a portion of which will subsequently be quoted. As it will be impossible to reprint in full, the tabulated results of these trials, it will be necessary to explain the method adopted (and now, I believe, agreed to as the standard by the Imperial Government), for estimating the exact amount of smoke produced by a given coal, consumed in the furnaces of any particular steamer. It is this:—Let the smoke issuing from the funnel of a steamer be noted every minute for an hour, upon a blank table, subdivided into minute-columns, similar to the table published with the Acadia coal-trial on the steamer “St. Lawrence” (Trial No. 2, of this Report). Let the figure 1, placed in a minute-space, indicate that the very faintest possible smoke, a mere indication of light-coloured gas was visible; 2, that this was increased, and so on to 6, indicating the densest black smoke. Having obtained these *smoke-marks* for an hour, the addition of them gives the *smoke-equivalent* for that time. This understood, the extract from Mr. Bunning’s paper above referred to, will become intelligible to the reader. After referring to the tabulated record showing the smoke-marks for every minute during his experiments, he states:—

Rule for estimating smoke.

“It will be seen that before the alteration, this smoke-equivalent averaged 107.9 over 25 experiments; that frequently, and for several consecutive minutes, dense black smoke was issuing from the chimney, and that there was rarely any actual cessation from smoke; while after the alteration no smoke of greater intensity than 2, was ever visible, and this only nine times in eighteen hours, for a minute each time; and that during the same eighteen hours the average smoke-equivalent was 7.7, each mark so rarely exceeded 1. This indicates that the very faintest possible smoke was visible only for 7.7 minutes in each hour, no smoke whatever being visible for the other 52.3 minutes. It would be vain to look for, nor indeed can any better results be found, even when the best of the so-called smokeless coals are burnt; for all practical purposes, therefore, good Hartley coal, as consumed in the *Weardale*, may be considered as smokeless as any other known coal. The plate* shows the alteration made to the fire-bars and bridge; the former were reduced from 5 feet to 3 feet 6 inches. The doors were not changed, and those shewn are those used by the Admiralty, admitting air at the bottom.†

Experiments on the Str. “Weardale.”

“The secret of burning the North Country steam-coal, and in fact all other good steam-coal, is to put it on as large as possible, as thick as possible, and to have as great a draft as possible, so as to burn off as large an amount per square foot of grate-surface as possible.”‡

Rule for burning North Country steam-coal.

* Published with Mr. Bunning’s paper.

† That is, the bottom of the door; the air passing into the fire through a perforated flash-plate.

‡ “On Experiments on the *Weardale*.” Trans. N.E. Inst. Mining Engineers, vol. xviii., pp. 105 et seq.

Farther trials
and alterations.

Since these trials, which were carried out in the winter of 1868-9, farther experiments have been made by Mr. Bunning on the Weardale, and some slight alterations made, among which may be mentioned the placing of a door at the hole piercing the plate between the ash-pan and air-plate flue, which being moved by a bar extending to the front of the furnace, permits the admission of air, *at will*, behind the fire. Under date of 14th April, 1870, Mr. Bunning (to whom I am indebted for much information on this subject, which I would here gratefully acknowledge, writes me :—

Success.

“ We consider the Weardale now perfect ; she makes absolutely no smoke, and keeps her steam well.”

A proper discussion of the rationale of these experiments, and of their importance to our coal-trade, must be postponed to some future occasion. Much more might be said in favour of the use of steam-coals of the class under consideration, and it can be clearly proved, that, if properly burnt, they are at least as economical, as smokeless, and as easily stoked as any other class of coals.

Use of New
castle coal in
the Navy.

The experiments above quoted, in connection with Government trials made at Devonport, already mentioned, have produced a material change of opinion with regard to Newcastle coal, and it has now taken a position second to none, among coals for the Navy, where it is chiefly used in admixture with Welsh coal, and the testimony of the very highest authority, is that a very large saving has already been effected by its use.

Necessity for
steam and
smoke-trials
of our coals.

It is hoped that enough has already been said to call the attention of our coal-owners and consumers to the urgent necessity of practical trials of a similar character to those above mentioned. Such experiments could be carried out at a very trifling cost, on any steamers, without interfering with their regular voyages ; and though the great results of the North Country experiments might not be obtained, still, a great addition would be made to our knowledge of the coals, and that a very material improvement in the matter of steam and smoke would be made, cannot be doubted.

I shall close these remarks, which have already exceeded the length originally assigned to them, by an extract from a circular of the Coal Trade Association of Newcastle-on-Tyne, just received from Mr. Bunning. It is of interest as showing the results of the very latest trials.

RESULT OF EXPERIMENTS AT PORTSMOUTH, 1869-70.

Experiments at
Portsmouth
1869-70.

“ A very comprehensive series of experimental trials have been carried out during the past twelve months on board Her Majesty’s steamers “Urgent” and “Lucifer,” at Portsmouth, with Welsh and North-

Country coal mixed, and burnt in two forms of furnace, for the purpose of ascertaining the best proportions in mixed coal, and form of furnace for the consumption of smoke. The trials have been carried out under the direction of Captain E. Rice, A.D.C. to the Queen, commanding the Steam Reserve at Portsmouth, and the superintendence of Mr. G. Murdock, Chief Inspector of Machinery to the Reserve ; and the results are considered to be so important, that orders have been issued from the Admiralty for the furnaces in the boiler-rooms of her Majesty's ships to be altered according to the plan finally adopted in the trials as the best for the consumption of smoke. When the comparative trials between the ordinary and the new form of furnace commenced, the proportions of the mixed coal burnt were one-third North-Country and two-thirds Welsh ; but in all the later trials the coals have been burnt in equal proportions, and under these latter conditions less smoke has been emitted from the smoke-consuming furnace funnel than has been emitted from the funnel over the ordinary form of furnace, when the latter was burning the very best description of Welsh coal. The last three trials made on board the " Urgent " afford conclusive evidence of the success of the new form of furnace over the old. In the trial made on the 27th ult., both sets of furnaces were used, the coal burnt being Ferndale and Cowpen's Hartley, in equal proportions. The report of this trial gave the following results :—

	New Furnace.	Old Furnace.
Smoke.....	1.55	4.55
Coal burnt per hour.....	2,940 lbs.	3,294 lbs.
Producing		
Ash.....	23.14	32.75
Soot.....	2.82	5.16
Clinker.....	35.08	25.00

" The last two trials made were on the 2nd and 11th insts., the new furnaces only being used on the former, and the old furnaces only on the latter trial, the coal burnt in each instance being equal quantities of Powell's Duffryn and Cowpen Hartley, with the following results :—

	New Furnace.	Old Furnace.
Coal burnt per hour.....	2,912	3,397.3
Producing		
Ash.....	17.73	24.34
Soot.....	1.94	4.06
Clinker.....	31.0	40.6

" In these two trials, the new furnaces exhibited a saving upon the old, of 14.28 per cent. in fuel, an increase of 7.56 per cent. in horse-power, and a positive gain in the consumption of smoke, of 21.84 per cent."

